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POTATO DISEASES IN NEW JERSEY

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Potato Diseases in New Jersey.*

Potato growing is one of the most important industries in New Jersey. In 1915 there were 93,000 acres in potatoes producing 12,090,000 bushels, or an average of 130 bushels per acre. This crop at $97.50 per acre, or $9,068,000 for the entire crop (U. S. Monthly Crop Report, December 30, 1915). However, the industry suffers very heavy annual losses, which are due primarily to three causes: unfavorable weather, insects and diseases. The weather conditions are beyond our control, except where methods of cultivation may help to conserve the moisture or where irrigation can be used to advantage. The most injurious insects are quite readily controlled, but the methods may be improved as the result of future experimental work. The diseases caused by fungi and bacteria are much more difficult to control and are the causes of the greater part of our losses. A conservative estimate of the annual losses in New Jersey potato production due to fungus and bacterial diseases will range from 10 per cent. to 25 per cent. Many of these losses could be prevented by the proper selection and treatment of seed and by the proper treatment of the growing crops.

ROTS.

Seed potatoes are often affected with soft rots, which may be due to any one of several causes. The most important, to the potato growers of New Jersey, is due to bacteria which

* Prepared December 1, 1915, by Mel T. Cook, Ph.D., and H. Clay Lint, M.S., of the Department of Plant Pathology, New Jersey Agricultural Experiment Station, as substitute for Circular 33, which is now out of print.

cause a rapid rotting of the tubers (Fig. 1). The soft, slimy pulp, containing millions of bacteria, is smeared over the surface of the sound potatoes in the handling, and some of it reaches the freshly cut surfaces by contact with the potatoes or from the cutting knife. If the cut potatoes stand for a short time before planting, black sunken spots, due to the action of the bacteria, appear on the cut surfaces. If the weather is warm the potato sprouts, and no great loss results from this rot. But if the weather is cold and wet many of the seed pieces rot, the result being a poor stand or weak plants. This rot was especially destructive in 1913.

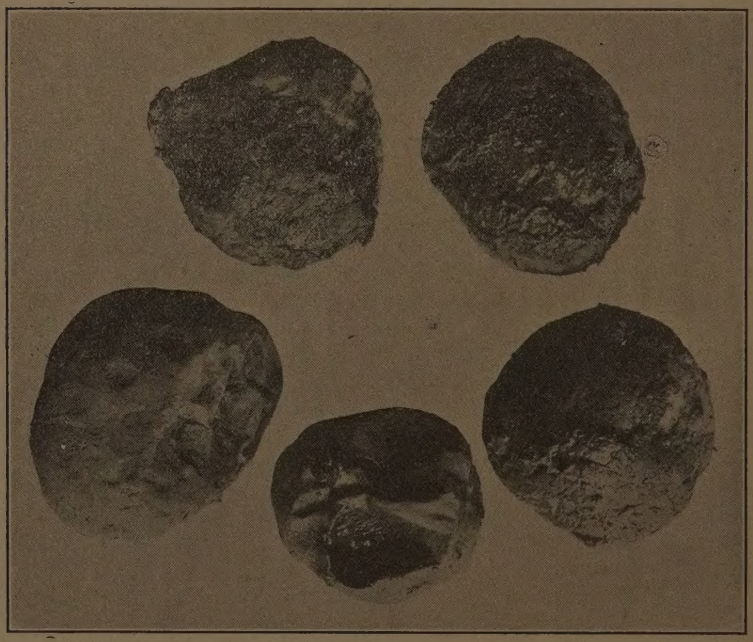

Fig. 1.—Bacterial Rot of Seed Potatoes.

Control.—Although the weather is the most important factor in the control of this trouble, the loss can be reduced by treatment of the seed with formaldehyde or corrosive sublimate, and by dipping the cutting knives in a 25 per cent. solution of for-

maldehyde (see page 19). This may be easily accomplished by having two knives for each cutter and letting one stand in the solution while the other is being used. This precaution has been adopted by many of the northern growers. It is also advisable to treat the cut seed with sulfur (see page 19).

Other soft rots due to black leg (*Bacillus phytophthorus*), to late blight (*Phytophthora infestans*), and to various other fungi (*Rhizopus nigricans, Fusarium solani,* etc.) are frequently present (see pages 6, 15).

SOUTHERN BACTERIAL WILT.

This disease, also known as the "sleeping sickness," is caused by *Bacillus solanacearum*, E. F. Smith. It attacks potatoes, tomatoes, egg-plants, peppers and tobacco (on which it is known as the Granville tobacco wilt), and is one of the most destructive diseases of the southern States. It was reported in 1903 as attacking tomatoes in this State. It is especially severe in dry seasons and on dry soils. It was very severe on the potatoes in the southern part of the State in 1913, and aside from weather conditions caused greater injury to the early Cobblers than any other one factor. The disease was decidedly more severe on potatoes grown from eastern seed than on those from New Jersey grown seed, and there was a slight amount of evidence tending to show that it was less severe on seed which had been treated with formaldehyde than on seed which had not been treated. The evidence on this point is, however, far from conclusive. It was severe as far north as Burlington, northward from which point the injury was less pronounced.

The disease first appears as a wilting, followed by a revival at night and a wilting on the second day. Plants very seldom survive the second day's wilting unless there should be intervening rains, but become yellow and blacken, and the tubers rot readily. The disease is carried by insects and in the seed, and in the southern States in the soil. It is probable that the cold weather of the north checks it to some extent, but this point has not been conclusively demonstrated.

Control.—Tubers from diseased vines should not be used for seed, and rotation of crops should be practiced. Other crops which are attacked by the disease should not be used in the rotation.

BLACK LEG.

This is one of the severe diseases of the potato which comes to us in seed, and is the cause of heavy losses throughout the State every year.

It is a bacterial disease (*Bacillus phytopthorus* Appel) and probably came to us from Europe. The affected plants are under-sized and very erect; the leaves are pale in color and tend to curl upward (Fig. 2). The stems die from the seed piece upward, turn black and become dry. We have no reason to believe that the organism causing the disease will persist from year to year in our New Jersey soils. The disease is always much more severe on crops grown from northern seed than on crops grown from second crop seed.

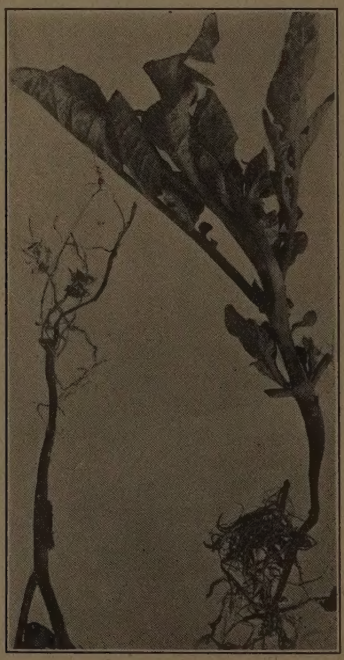

Fig. 2.—Black Leg.

(From Farmers' Bulletin 544, U. S. Dept. of Agriculture.)

The disease also causes a rotting of the tubers (Fig. 3), beginning at the point of union with the plant and gradually working inward. Tubers in which the rot is well advanced may be mashed and smeared over the sound tubers and thus spread the disease. Very slightly infected tubers are frequently overlooked by the cutters. Usually plants from diseased seed pieces will die before the tubers have reached a market size.

Fig. 3.—Tuber Rot, Due to Black Leg.
(From Farmers' Bulletin 544, U. S. Dept. of Agriculture.)

Control.—Throw out all seed tubers that show evidence of the disease. Treat the seed with formaldehyde or corrosive sublimate (see pages 18, 19).

COMMON SCAB.

This is one of the most common and best known of the potato diseases, and yet one which is very generally neglected by the growers. It is caused by *Oospora scabies* Thaxt. (*Actinomyces chromogenus* Gasparini), varies from a very slight russeting

to pronounced roughness. In extreme cases the tubers are small and the roughness takes the form of holes, which are frequently one-sixteenth to one-fourth of an inch deep.

The organism causing this disease can be carried on the seed, in the dust on healthy tubers, and in manure from animals fed on diseased tubers; it will also persist in the soil. It is most severe in alkaline soils, and growers should therefore avoid the use of lime, wood ashes, soda, and stable manure on potato lands unless applied with other crops in rotation. The disease also occurs on beets, turnips and some other plants.

Control.—(a) Select smooth seed, (b) disinfect with formaldehyde or corrosive sublimate (see pages 18, 19), (c) plant in clean soil following a green crop, (d) avoid alkaline fertilizer, (e) do not plant on infected soil for three to five years, (f) do not use beets or turnips in the crop rotation.

POWDERY SCAB.

This disease is quite different from the common scab, but resembles it somewhat. It is caused by a slime mold (*Spongospora subterranea* Wallr., Lag), and was probably introduced from Europe. The spots are covered when young, but when mature break into brownish, powdery masses. It is difficult for the inexperienced person to distinguish this disease from the common scab. The most pronounced characters are a more or less regular arrangement of the spots in rows, a peeling back of the skin around the spots and the reddish powder or spores within the cankers. It is said to be a very serious disease in Europe. It is now known to exist in Canada, parts of Maine and New York, and possibly in some other parts of the United States. Observations and experiments conducted in 1915 indicate that it is not likely to prove serious in New Jersey and points farther south. Thus far no satisfactory method of seed treatment has been devised. Until we have more definite knowledge of the subject, our New Jersey growers should use every reasonable precaution to secure seed free from this disease.

POTATO WART.

This is one of the most important European diseases. It is caused by a fungus (*Synchitrium endobioticum* Perc.), and is extremely difficult to control. It has been introduced into Newfoundland. On the severely affected tubers it causes coral-like,

scaly nodules, which are readily recognized. Seed potatoes may be slightly affected and escape notice. The danger of the introduction of this disease has been greatly reduced by the quarantine which the United States Department of Agriculture has placed on all foreign countries in which it is known to exist. However, our growers should be constantly on the lookout for it.

SCURF OR RHIZOCTONIA.

This widely distributed disease occurs in several different forms and is known under correspondingly different names as "scurf," "brown stem," "Rhizoctonia," "little potato," "aerial potatoes," "rosette" and "stem rot". The disease is caused by the fungus "Rhizoctonia" or *Corticium vagum* B. & C. var. *solani* Burt. This disease is more or less abundant every year, but was especially severe in 1915. Some of the symptoms are common to other diseases and this, no doubt, frequently leads to some confusion. The diseased tubers show small black spots (sclerotia) which do not wash off, but which can be readily scraped off with the finger-nail (Fig. 4). These small black spots

Fig. 4.—Tuber Covered With Scurf Sclerotia.

are the resting stage of the fungus. It is by means of these sclerotia that the disease is carried over from year to year on the seed tubers.

The organism may also exist in the soil, but its presence in the soil or on the potatoes does not necessarily indicate that it will prove a serious disease in the coming crop. It is undoubtedly influenced by soil, temperature, moisture or some other factors not well understood.

The disease varies in appearance and severity with varieties. The most common forms are as follows:

(a) *Poor Germination.* Some of the seed pieces fail to germi-

Fig. 5.—Poor Germination Resulting from Rhizoctonia.

nate, others produce short, thick sprouts which never break through the ground (Fig. 5); others produce spindling, white sprouts which die back or produce weak plants. In the case of dying back, a second and even a third shoot may be produced (Fig. 6). In case of repeated dying back, many spindling shoots may finally be produced from the seed piece.

(b) *Brown Stem* and *Cankers.* The poor germination is accompanied by a browning of the stem. This brown area fre-

quently assuming the proportions of well defined *cankers* (Fig. 7). These brown areas and cankers may be found on plants of all ages.

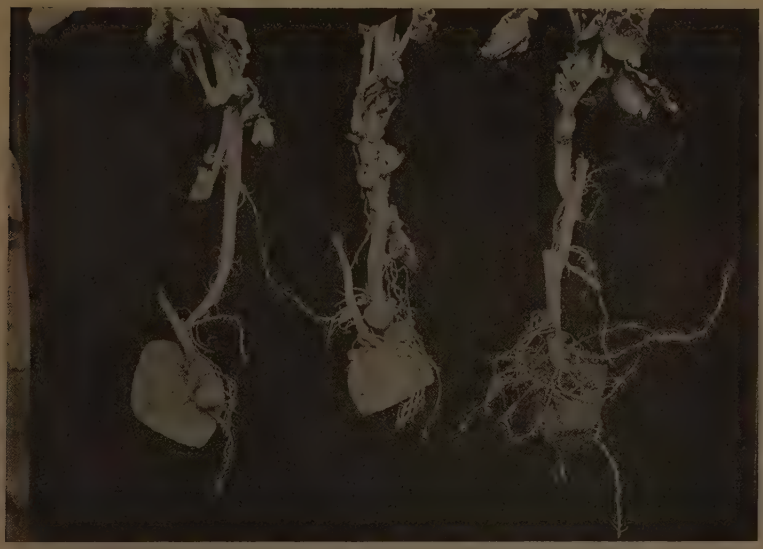

Fig. 6.—Poor Germination Resulting from Rhizoctonia.

(c) *Crinkle Leaf.* On the foliage of the weaks plants, and in many cases of fairly good-sized plants, the first foliage is crinkled with a tendency for the edges of the leaves to turn downward. The later foliage is smooth and apparently normal in every way. The crinkle leaf character is especially prominent on Giants, Green Mountains and similar varieties.

(d) *Roll Leaf.* In the latter part of the season the tip leaves tend to roll in a manner suggesting the leaf roll. This character is especially prominent on the Irish Cobblers and similar varieties.

(e) *Little Potato.* Many small tubers are produced on seriously diseased plants. We have found as many as forty-two tubers on a single plant. This phenomenon is most common on the early varieties and may be due to other causes.

(f) *Aerial Potato.* Small tubers are frequently found on the stem, in the axils of leaves, above ground. This character is

usually associated with "little potato" and also may be due to other causes.

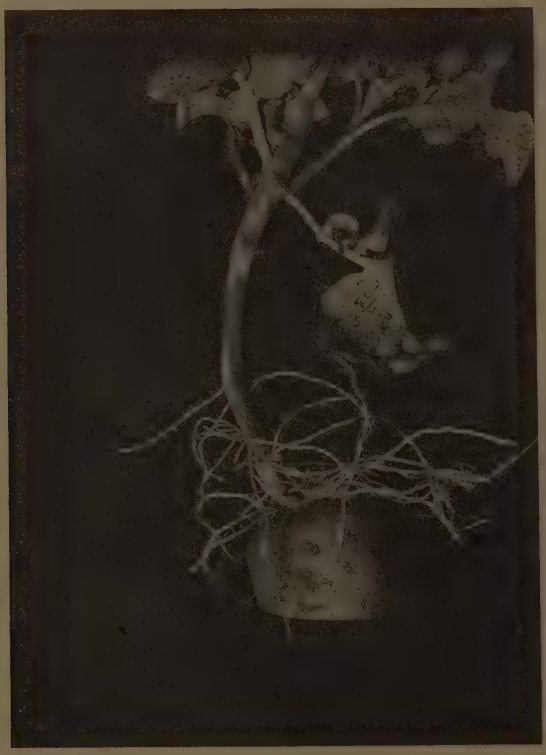

Fig. 7.—Canker Resulting from Rhizoctonia.

Control.—Use clean seed if possible and *always* treat the seed with formaldehyde or corrosive sublimate (see pages 18, 19). Experiments conducted on the New Jersey Agricultural Experiment Station Farm in 1915 and reports from other States show that corrosive sublimate is much more satisfactory than formaldehyde. Rotation of crops should be practiced where practical, and turnips and beets should never be used in the rotation.

SILVER SCURF.

This is a fungus disease (*Spondylocladium atrovirens* Harz.) which was introduced from Europe a few years ago. It appears as a dark spot on the skin and in mild forms may escape the notice of most growers. In storage, these spots enlarge, and the tubers shrivel and become somewhat silvery in appearance. This disease is quite common on seed coming into New Jersey and has also been found quite abundant in some plantings. It does not appear to be a very serious disease for New Jersey growers.

Control.—Throw out tubers that show evidence of this disease.

DRY ROT AND WILT.

This is a very common and widely distributed fungus disease (*Fusarium oxysporum* Schlect) of the potato, and is frequently

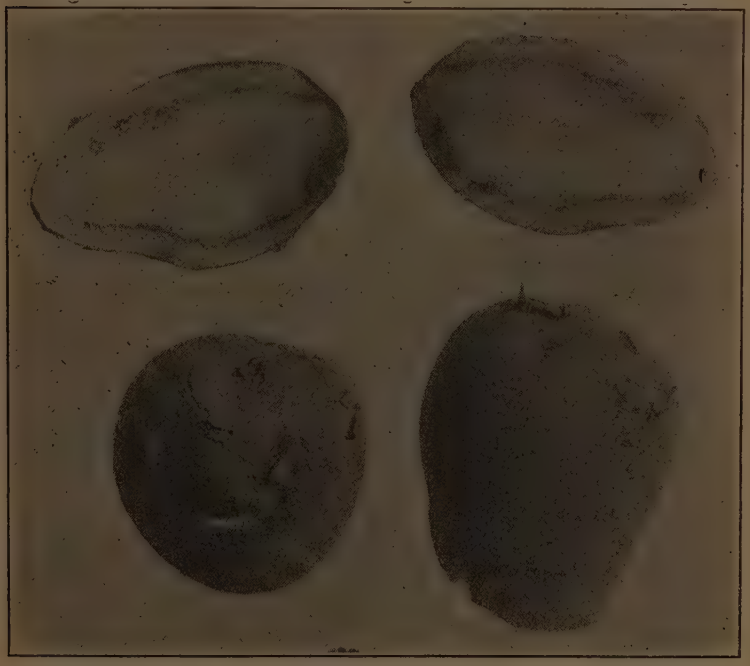

Fig. 8.—Fusarium Rot.

referred to as "Fusarium wilt" and "stem blight." It can be recognized in the tuber by the black discoloration starting at the stem and just below the peel. This disease causes a dry rot in winter storage. In the field the diseased plants wilt and die prematurely, the stems blacken and rot at the surface of the ground, and are frequently covered with a delicate white or pink fungus growth. When the diseased stems are cut across, the fibro-vascular bundles are found to be black and dead (Fig. 8).

Control.—Throw out all seed that shows black discolorations when cut. Use a five-year crop rotation for infected fields.

OTHER DRY ROTS.

Other species of Fusarium are the causes of storage rots. Among the most important are *Fusarium trichothecioides* Wr., which causes a powdery dry rot in the western states and *F. tuberivorum* Wilcox, which causes a dry rot in Nebraska. These rots have not been reported from New Jersey.

VERTICILLIUM WILT.

This is due to a fungus (*Verticillium alboatrum* Reink and Berth) and is very similar to the Fusarium wilt. The black discoloration of the tuber is much more pronounced than in the case of the Fusarium wilt and the wilting is more rapid. It is less common and not so widely distributed. We have found this disease but once in this State.

EARLY BLIGHT.

This very common and widely distributed fungus (*Macrosporium solani* E. & M., J. & G.), attacks both potato and tomatoes and is frequently the cause of heavy losses. It appears as dark, grayish spots on the leaves, within which delicate, black, concentric circles are frequently formed. These spots increase in size, and unite, forming irregular blotches and frequently destroying the entire leaf. Flea beetles and other insects carry the disease from plant to plant. This disease is not apt to be serious on vigorous, well-fed plants. It is usually more severe on the second crop than on the first. It is more severe on plants that have been injured by paris green than on normal plants. It is also more severe on tomatoes than on potatoes.

Control.—Spray with Bordeaux mixture or other good fungicide (see page 22).

LATE BLIGHT.

This, one of the most destructive diseases of the potato, is caused by the fungus *Phytophthora infestans* De By. It is common in northern potato-growing districts and in the mountainous districts of the southern states. It is especially severe in cool, moist weather, frequently causing the foliage to wilt and blacken in a very few hours. It also causes a soft tuber rot in the fields and a dry brown rot in storage.

The cut surface of diseased tubers shows a rot causing a brownish, yellowish, or marble discoloration which may originate at any point (Fig. 9). Diseased tubers are more or less common in northern seed. These diseased tubers fail to germinate, or produce weak plans which give a very poor yield or die very early. This disease is more or less common in the mountainous counties of New Jersey, but cannot be said to be of much importance.

Fig. 9.—Late Blight Dry Rot.

(From Farmers' Bulletin 544, U. S. Dept. of Agriculture.)

Control.—Throw out all infected seed, *i. e.,* tubers showing brown discolorations when cut. Spray with Bordeaux mixture or other fungicide, in the same manner as for early blight (see page 22).

LEAF ROLL.

The cause of this disease is not definitely known. It was much more abundant in 1915 than in previous years. It usually appears in late summer and is characterized by an upward rolling

of the edges of the leaves accompanied by a change in color to a pale green, yellow, red or purple tint. The plants do not die quickly and do not show the cankers as in the case of Rhizoctonia. The diseased plants produce few or no potatoes, or many small ones, clustered about the base of the stem in the same manner as described for Rhizoctonia (see page 11). Aerial tubers may also be produced in the same manner as described for Rhizoctonia (see page 11). It has been demonstrated that seed tubers from diseased plants will carry the disease into the next generation.

Control.—Use seed from healthy plants.

MOSAIC.

This disease is also of unknown cause, but can be carried in the seed. It causes a dwarfing of the plants, accompanied by a peculiar mottled appearance or crinkling of the foliage. It is especially severe on the Green Mountain types.

Control.—Use seed from healthy plants.

CURLY DWARF.

This disease is also of unknown cause, but is believed by many to be an advanced stage of the mosaic. It is characterized by a pronounced dwarfing of the plant and foliage symptoms similar to those of the mosaic.

Control.—Use seed from healthy plants.

SUN WILT OR SCALD.

This is a wilting and sometimes a burning of the young foliage. It is most common in bright hot weather following prolonged periods of rainfall.

RUSSET.

A peculiar russeting of the tubers was referred to in Circular 33 of the New Jersey Agricultural Experiment Station. We stated at that time that this russeting was due to an unknown cause, but "appeared to be very generally associated with scab". Further studies and observations lead us to believe that this disease may be a mild form of either scab or Rhizoctonia.

NET NECROSIS.

This is a peculiar disease of unknown cause appearing as dark brownish zones or streaks in the tuber. These discolorations originate at the point of attachment to the vine and are some-

times mistaken for *Fusarium* or *Verticillium* wilt. The reports concerning this disease are somewhat conflicting, but there is some evidence that it can be transmitted in the seed.

ARSENICAL POISONING.

Spotting and dying of the foliage is frequently caused by the application of paris green or other arsenical poisons. It is frequently mistaken for blight and injures the plant in proportion as it reduces the amount of green surface. The injured foliage also offers favorable opportunities for the development and spread of the early blight (see page 14).

Control.—Paris green should always be mixed with lime, whether applied dry or in water. It can be applied with Bordeaux mixture without additional lime. Arsenate of lead can also be applied with Bordeaux mixture. The latter spreads and sticks better than paris green, but acts more slowly.

TIP BURN.

This disease is frequently mistaken for blight and most of the reports of blight in New Jersey are tip burn. This disease is due to hot weather and is usually most severe in dry weather, but also may prove very severe in wet seasons. It causes the leaves to die, beginning at the tips and margins, the stems holding their normal position. It is often caused by applying a wet spray to the vines under a hot sun.

Control.—Plant on soil rich in humus and give good surface cultivation to conserve the moisture. Irrigate where possible. Spray with Bordeaux mixture in order to keep the foliage in healthy condition. Do not use a wet spray in bright sunlight.

SEED SELECTION.

It is very important to use good, vigorous seed if we expect to secure the best results. The seed should be from vigorous, productive plants, relatively free from disease and true to name. A weak plant may produce one or two fair-sized tubers, and the grower who buys his seed from other localities, in most cases, has no way of knowing the character of the plants from which his seed was harvested. Neither has the grower any way of knowing the prevalence of other diseases of the potatoes on the seed producer's farm. All growers know the difficulties arising from seed containing more than one variety.

During the past few years some of the seed-producing states have endeavored to overcome these difficulties by a system of

inspection. Growers wishing to improve their seed, enter their fields for certification in a manner provided by the State officials in charge of the work. The fields are inspected during the growing season, at about the time of blooming, and again as late as possible before the dying of the plants. The crop is inspected a third time after digging for diseases which do not show on the parts above ground. These crops must conform to a certain standard of vigor, freedom from disease and trueness to type in order to be certified. Such seed is sold in sealed bags and carries a certificate of inspection. The expense of the inspection is borne by the grower. Therefore, the cost of the seed to the New Jersey buyer is slightly increased, but the increased yield resulting from the use of such seed should more than compensate for the added cost.

The use of certified seed should give us crops more nearly true to type, and with less black leg, scurf, mosaic, leaf roll and other diseases. Growers should not confuse the certified seed referred to above with the United States Government inspection of 1913 to 1915. This inspection was for powdery scab only, and gave no consideration whatever to other diseases, vigor or trueness to type. It has been discontinued.

SEED TREATMENT.

It has been demonstrated that it is advisable to treat the seed with formaldehyde or corrosive sublimate for scab, black leg and scurf (Rhizoctonia). The fact that these diseases sometimes appear on crops grown from treated seed is not an argument against the treatment. Repeated experiments in many parts of the country prove the advisability of treating the seed. It should be done by the grower.

The most satisfactory method of using FORMALDEHYDE (Formalin) is to mix one pint (or pound) of the commercial 40 per cent. solution in 30 gallons of water and soak the potatoes for 2 hours. This is most easily accomplished by partly filling sacks with potatoes and putting them in the barrels containing the mixture. The mixture can be used eight or ten times. It is not dangerous to handle but it causes an irritation of the eyes and the nose. *Always spread the treated seed in a thin layer so that they may dry as rapidly as possible.* Too long an exposure to the liquid will injure the germination. It is best to give the treatment before the seed sprouts. The treatment will kill most of the sprouts that may be started at the time, but good seed will produce new sprouts.

Corrosive Sublimate solution is also an excellent treatment for scab on seed potatoes and is more effective against the scurf (Rhizoctonia) than the formaldehyde. Mix 4 ounces of corrosive sublimate in 30 gallons of water and soak the potatoes for 1½ hours. Caution: *Do not mix the solution in a metal container. Corrosive sublimate is a deadly poison, and must be kept out of reach of children and irresponsible persons. The mixture can be used four or five times.*

The cutters should use two knives; one should be kept in a cup of formaldehyde (1 part to 19 parts water) while the other is in use. These knives should be changed frequently and always immediately following the cutting into a tuber showing discolorations, rots or other evidence of disease.

All tubers showing discolorations, rots and other internal evidence of disease should be thrown out.

The practice of dusting cut potatoes with sulfur, gypsum, slaked lime, etc., is quite common among many of the growers in the State. The use of any of these materials results in the more rapid formation of an artificial skin, thus reducing the amount of water lost from the seed piece. Of these materials the sulfur is probably the better, since its fungicide properties are more marked. This treatment is not beneficial when the planting season is cold and wet.

METHODS FOR SOIL TREATMENT.

Even before the organism causing potato scab had been isolated, experiments had been conducted in which many substances were introduced into the soil for the purpose of controlling the disease. With the discovery of the organism, the work with soil fungicides was resumed in a more intelligent manner until to-day we have a considerable amount of accurate data.

Many of the substances tried have been found partially effective but too expensive for commercial practice, others have been found worthless, and others even tend to increase the scab. The influence of some of the more common materials applied to the soil for the control of scab may be summarized as follows:

Barnyard Manure.—Much work has been done upon the influence of barnyard manure upon potato scab with the almost invariable result that the amount of scab is materially increased. Fresh manure is apparently more likely to be injurious than old or composted manure. In general, the higher the rate of application, the greater the amount of scab. There can be little doubt

that applications of manure should be made on the other crops in the rotation, rather than immediately before or on the potatoes.

Lime.—This material likewise has been found to favor the development of scab, and applications of lime are not to be recommended on the potato crop. The tendency of potato soil to become acid and the difficulty of obtaining a good catch of clover for a cover crop upon such soils, makes the application of lime necessary at some place in the potato rotation. The best time to apply lime in a potato rotation is immediately after the crop is dug.

Wood Ashes.—This material is but little used at present, and there is little doubt that it is favorable to the development of scab to a marked extent.

The relation of a number of other substances to the development of scab has been investigated. *Kainit* and *potash* salts have been found to decrease the scab. *Bone meal* has been found to increase the scab. *Copper sulphate* (Blue vitriol) and *Mercuric chloride* (Corrosive Sublimate) and *Sulfuric acid* have shown beneficial results in the control of the disease.

One of the most promising of the materials tested, and one whose cost is not prohibitive, has been found to be *sulfur*. Dr. B. D. Halsted, Botanist of this Station, was among the first investigators to test out this element. His results, and those of many other experimentors, have been very favorable. During the last two years the study of the influence of sulfur has been resumed by the writers. A brief summary of some of the phases of the problem which are of practical importance are given at this time in advance of complete statement of the results. (A more detailed account of this work is found in the Annual Reports of the New Jersey Agricultural Experiment Station for 1914 and 1915.)

(1) Influence of cover crop. The results in 1914 showed an increase in the yield of potatoes of 21.4 bushels per acre on soil which had grown a cover crop over soil where no cover crop was grown. The tests with sulfur on these soils showed that sulfur is more effective on the soil where no cover crop has been grown.

(2) Influence of the time of application. In the work carried out in 1914 a number of tests of this factor were made. Spring application of the material proved a great deal more effective than a similar application made the previous fall. This phase of the problem was carried out but the one year, but the results

point clearly to the advantage of making sulfur applications in the spring about the time of planting.

(3) Influence of the method of application. Tests of this phase of the work were carried out in both 1914 and 1915. The results for both years indicate that mixture of the sulfur with the fertilizer not only fails to show much control of the scab by the sulfur, but also a decrease in yield. A comparison of broadcasting "before" and "after" planting was made both years, and which is the better is still an open question. In 1915 the results were in favor of broadcasting before planting.

(4) Influence of the formaldehyde treatment of the seed. The influence of this treatment as outlined in this circular (pages 18, 19) has been tested for two years. In testing the effectiveness of sulfur it has been found that the best results are to be obtained with seed previously treated with formaldehyde.

(5) Influence of the form in which the three essential elements, nitrogen, phosphoric acid and potash, are added to the fertilizer. The evidence presented through two years' experimental work on this point has indicated that (a) sulfur is more effective where phosphoric acid is supplied as acid phosphate than when bone-base fertilizers are used. (b) Sulfur makes a larger increase in the per cent. of clean potatoes with muriate of potash than with sulfate of potash. (c) The results on the source of nitrogen have been different for the two seasons and are inconclusive.

Applications of sulfur at the rates of 300 pounds per acre and 600 pounds per acre have been used, and in general a marked decrease in the amount of scab has resulted from the larger application. Deleterious effects are sometimes noted on the crops following potatoes, particularly clovers. The injury in no case has been observed for any great length of time. The smaller application, 300 pounds per acre, has not been found to be injurious, and the evidence to date indicates that small annual applications are more satisfactory than one large application. The influence of sulfur in the second year in the control of scab is apparent, but not to as great an extent as in the first year. The acidity of the soil is apparently the most prominent factor in limiting both the benefits and the injury due to sulfur treatment, so that any applications should be made in a small experimental way in each particular field before any extensive control work is undertaken.

POTATO SPRAYING AND DUSTING.

An increase in the yield of potatoes due to spraying may be the result of several factors, two of which are:

(1) Control of fungus diseases.

(2) Vine stimulation and invigoration.

The fungus diseases which can be controlled by spraying have been described in the foregoing pages, and studies on vine stimulation have shown that under some conditions it may become an important factor.

Covering these two phases of the spraying problem, the Experiment Station has tested Bordeaux mixture and sulfur-arsenical dusts. In addition, several of the commercial Bordeaux pastes sold within the State have been used. The meagre tests of these materials have not furnished a great deal of data regarding their relative merits. A safe rule to follow with respect to these materials is to adhere to the printed recommendations of the manufacturers.

Home-made Bordeaux mixture has been the most popular spray material in the big potato-growing sections of the world ever since its efficiency in the control of late blight was established. Extensive spraying work in New York and New England has demonstrated the advisability of its use. In Maine and Vermont the increase in yield due to spraying, even in years when no blights were present, has been quite marked. In the ten years' spraying experiments by the New York Experiment Station, the average increase due to Bordeaux spraying at Geneva was 97.5 bushels per acre for five to seven sprayings per annum and 69 bushels per acre for but three sprayings. On Long Island, where the conditions more nearly approximate those of New Jersey, the increase in yield due to spraying was not so large. An average annual increase of 45.7 bushels per acre was brought about by five to seven sprays, and only 25 bushels per acre from three applications of spray. These results need not necessarily apply to New Jersey conditions. On Long Island the spraying does not pay every year. From our limited experimentation in this State it is probable that spraying would not be commercially profitable every year, but still prove a profitable practice for a period of years.

During the last three years extensive field tests of Bordeaux mixture have been made by this Station. The results have differed somewhat with the localities and with the variety of pota-

toes grown. In the two years' work at Freehold, no increases outside of experimental error have been obtained by spraying "Giant" potatoes. These experiments were conducted on one of the richest fields in that district, and high fertility and variety of the potatoes grown have been suggested as probable causes for the failure to obtain material increases in yield.

With Irish Cobbler potatoes the Bordeaux spraying has given more promising results. As high as 61 bushels per acre increase was noted in one experiment. Increased yields have not been obtained in all cases, and with our meagre data and incomplete knowledge of the influence of the character of the seed, of climate, and several other factors, it is not possible to predict a paying increase every year from Bordeaux spraying.

The results of spraying second crop Irish Cobbler potatoes in 1915 are very promising. Early blight is quite common in these late planted potato fields, and since Bordeaux effectively controls this fungus, we may expect a larger return from spraying here than on the early crop where this disease is absent.

For the first crop potatoes, the first application of Bordeaux spray should be made when the vines are 6 to 8 inches high. The treatment should be repeated every ten to fourteen days, the time of application depending somewhat upon weather conditions. The largest number of applications of spray per season tested in the experimental work on first crop potatoes is four.

Liquid sprays are best applied at the rate of about one hundred gallons per acre and the best coating of the leaves is obtained with three nozzles to the row. A pressure of at least one hundred pounds per square inch is highly desirable.

Complete directions for the preparation of Bordeaux mixture are to be found in Circular 48 of this Station. A detailed report of the dusting and spraying work of this Station is contained in the Annual Reports for 1913, 1914 and 1915, and in Circular 42.